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## (54) SOLID FUEL ROCKETS



(71) We, DYNAMIT NOBEL AKTIEN-GESELLSCHAFT, a German Company, of 521 Troisdorf, near Cologne, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to solid rocket propellants and is concerned with an insulating composition for the production of an insulating layer on solid rocket propellants.

Solid propellants for propelling rockets comprise constituents which decompose or react with one another exothermally on combustion to form propellant gases. These solid propellants thus consist of a system comprising a fuel and an oxidant which may either be combined together in the same molecule or be present as separate entities in the form of a homogeneous or heterogeneous mixture.

In the rocket art, double base or polybase powders produced without the use of dissolving agents, also called POL powders, are of special importance. Of these powders, the double base powders, which are mainly used, contain in addition to nitrocellulose also a high-energy liquid nitric acid ester, for example, nitroglycerine, while the triple base POL powders contain, as third base, another nitro compound, for example nitroguanidine. In addition to these POL powders, there is also another class of solid propellants which are used in many cases. This class consists of the so-called composite solid propellants, which also comprise constituents which undergo combustion and which decompose or react with one another exothermally to form propellant gases. In this case, the fuel and oxidant are usually present as a heterogeneous mixture, inorganic perchlorates, for example ammonium perchlorate or an alkali metal perchlorate, being usually used as the oxidant and organic polymers, for example polyesters, polyamides, polybutadienes or polyurethanes, being usually used as the fuel.

In the production of solid propellant compositions from POL powders or composite propellants, stabilisers, plasticisers, burning regulators and lubricants are also generally incorporated in the initial materials. Thereafter, the mixtures are shaped, either directly or by extrusion, and possibly *via* an intermediate stage in which the mixtures are converted into granulated form. Processes are also known in which the solid propellant compositions are produced by casting slimy mixtures of the initial components in moulds or by drawing the liquid components into a solid mixture of the other components by means of a vacuum, followed by curing, possibly at elevated temperature.

During the highly exothermic burning away of solid propellant compositions comprising cast or extruded double base or polybase POL powder solid propellants or composite solid propellants, much heat is liberated. This is particularly the case where solid propellants having a high heat of combustion and high density are used. As a result, the mechanical strength of the rocket combustion chambers in which the solid propellant compositions are arranged, and which are usually formed of steel, light metal alloys or even of reinforced synthetic plastics, is badly affected. Indeed, the rocket combustion chambers are frequently destroyed during operation. Consequently, it is of particular importance to protect the walls of the combustion chambers against the effect of the heat. For this purpose, a firmly adhering and thermally stable insulating layer which is not spontaneously combustible can be arranged on a surface of the propellant composition, so that the predetermined burning away of the solid propellant composition can only take place over its uninsulated surfaces. Solid propellant compositions having a surface provided with such an insulating layer to prevent burning occurring on that surface subject the walls of the combustion chambers to small thermal stressing only, especially when the propellant

compositions are of the internal burning type. Such insulating layers can, for example, be applied to the surface of the propellant composition by spraying, casting, brushing, dipping or wrapping.

It is already known to use conventional insulating materials, for example cellulose derivatives or polyvinyl acetate, for the production of such insulating layers. Moreover, it is known to use insulating compositions comprising a synthetic resin and fire-inhibiting fillers, such as silicon dioxide or barium sulphate, advantageously in powder form, as well as the usual hardener, accelerator, stabiliser and plasticiser additives. In this case, the synthetic resin is used as binder. The synthetic resins mainly used for this purpose are polyepoxides and resins which are based on polyesters, polyurethanes, polyamides, polyvinyl chloride, polymers of dienes (advantageously polymers of butadiene) and mixed polymers of these dienes with olefins or compounds of the acrylic acid series (including alpha-alkyl-substituted derivatives of acrylic acid). However, when such binders are used for the production of insulating layers, they have a number of disadvantageous properties. For example, during the processing of these binders, organic solvents usually have to be used in order, for example, to obtain the insulating composition in a state suitable for processing. In this case, the solvents tend to diffuse into the solid propellant composition and thus phlegmatise a more or less deep layer of the composition whereby the burning properties of the composition are disadvantageously influenced. Furthermore, despite their often good low-temperature elasticity and adhesion to the surface of the propellant composition, such binders are disadvantageous in that they usually have comparatively low softening and decomposition temperatures. As a result, the insulating layers obtained tend to have low mechanical strength and thermal resistivity at the temperatures, pressure and gas velocities which arise during the burning of the solid propellant composition in the rocket combustion chamber. Consequently, fragments of the insulating layer are frequently ejected from the nozzle of the rocket combustion chamber which together with the development of noise which frequently cannot be avoided when using binders having a high carbon content and based on synthetic resins, makes difficult the operation, control and observation of guided missiles powered by compositions provided with such insulating layers.

According to the present invention there is provided an insulating composition suitable for the production of an insulating layer on a solid rocket propellant composition comprising a double base or polybase powder or in the form of a composite solid propellant, which insulating composition comprises:—

- (a) from 30 to 90% by weight of a solvent-free hardenable binder comprising a prepolymer, a condensate, or a mixture thereof,
- (b) from 5 to 65% by weight of an inorganic filler, and
- (c) from 5 to 50%, by weight of a substance which absorbs heat by undergoing an endothermic reaction as the insulating composition burns.

Advantageously suitable as solvent-free binders are liquid initial products (prepolymers) of polyepoxide resins, polyester resins, homopolymers or copolymers of dienes, and polyurethanes, which can be hardened or cured at room temperature or at elevated temperature after the insulating composition has been applied to the surfaces of the propellant composition (which surfaces may be pre-treated with suitable adhesion promoters for example aromatic diisocyanates). Preferably the solvent-free binder includes an amine hardener (e.g. methylene-bis-*o*-chloraniline) for the polyurethane prepolymer. The polyurethane prepolymer may for example be a viscous prepolymerised diisocyanate derived from toluylene diisocyanate and butane-1,4-diol and may have a mean molecular weight of 2000 and an effective isocyanate content of 4% by weight. In a particularly preferred embodiment, the binder comprises (a) 63.1 to 81.1 parts by weight of a viscous, pre-polymerised diisocyanate obtained from toluylene diisocyanate and butane-1,4-diol and having a mean molecular weight of 2000 and an effective isocyanate content of 4% by weight and (b) 6.9 to 8.9 parts by weight of methylene-bis-*o*-chloraniline in solution in (c) 30 to 10 parts by weight of dimethylglycol phthalate as plasticiser. As hardener additive, there is used an amine which guarantees a particularly long processing time (pot life) insofar as the workability of the binder is concerned.

The inorganic filler present in the insulating composition according to the present invention may be a powdered filler, such as titanium dioxide, silicon dioxide, lithopone or barium sulphate. Preferably, however, the filler is a fibrous filler since fibres impart to the resultant insulating layer a substantially better mechanical strength than is the case where fillers in powder form are used. Suitable fibrous fillers are, for example, refractory fibres consisting of glass, quartz or magnesium oxides, fibres of boron, silicon, carbon or titanium, and, more especially, asbestos fibres. It is of particular advantage for the filler to include both powdered fillers and fibrous fillers and, in this case, the filler is preferably a mixture of lithopone powder and asbestos fibres.

It has surprisingly been found that the mechanical strength and thus also the thermal stability of the insulating layers obtained using the insulating compositions of the present invention can be considerably improved

even further if the fibrous filler is subjected, prior to being used, to a thermal pretreatment at relatively high temperatures, for example

- 5 This is advantageous, especially in the case of naturally occurring fibres such as the asbestos fibres which are freed from included water of crystallisation by for example a heat-treatment lasting 2 hours at temperatures of  
10 up to 800°C. and consequently shrink. On the other hand, if fibres which have not been heat-treated or pre-shrunk are used in the insulating composition, the subsequent shrinkage can have a disadvantageous effect on the  
15 mechanical and thermal stability of the resultant insulating layer. In the case where asbestos fibres are used, it is preferred for these to have an average fibre length of about 3mm and to be preheated at a temperature of up  
20 to 1000°C. for from 1 to 4 hours.

- By the term "substance which absorbs heat by undergoing an endothermic reaction as the insulating composition burns" there is meant a substance which sublimates when heated;  
25 decomposes without residue and endothermally into gaseous, invisible decomposition products; decomposes endothermally to form refractory residues (possibly through intermediate stages); or reacts endothermally with  
30 individual components of the insulating composition or with the combustion products of the propellant composition. For the sake of simplicity, such substances are hereinafter referred to as "coolants". The presence of the  
35 coolant in the composition affects the viscosity thereof. The viscosity of the final insulating composition has a bearing on the ease with which the composition can be processed to form the insulating layer and hence the amount  
40 of coolant which may be incorporated in the composition depends, *inter alia*, on the viscosity of the final insulating composition.

- Ammonium salts and acid amides of aliphatic and preferably straight-chain dicarboxylic acids with 2 to 8 carbon atoms, for  
45 example, those of oxalic acid, such as ammonium oxalate or oxamide, have proved to be particularly suitable as coolants in the insulating composition according to the present invention. These compounds decompose endothermally and free from residue with the  
50 formation of colourless and relatively cool reaction products, mainly water, hydrogen, ammonia and oxides of carbon, which thus protect the binder of the insulating layer. However, it is also possible to use as coolants  
55 synthetic plastics materials which depolymerise endothermally and without residue and with the formation of colourless, relatively cool decomposition products. Oxymethylene  
60 polymers, more especially polymers of formaldehyde, are examples of suitable synthetic plastics materials for this purpose.

- 65 As well as or instead of the previously mentioned coolants it is also possible with

particular advantage to use as coolant a substance which does not become gaseous without leaving a residue but which, possibly through endothermal decomposition taking place through intermediate stages, forms a refractory residue, for example an oxide, and thus acts as an additional refractory filler for the composition. It has surprisingly been found that a particularly good mechanical and thermal stability of the resulting insulating layer is obtained when such coolants are present and their refractory residues, either alone or together with other components of the composition (e.g. refractory fillers and especially asbestos fillers), form sintered bodies, for example in the form of mixed oxides, at the temperatures produced during combustion of the propellant. Coolants which have proved especially suitable in this connection are ammonium salts of isopoly and/or heteropoly acids which contain boron, silicon, phosphorus or titanium as central atoms, especially the tetrahydrate of the ammonium pentaborate  $[(\text{NH}_4)_2\text{B}_5\text{O}_{14} \cdot 4\text{H}_2\text{O}]$ .

The grain size of the coolant used in the insulating compositions of the present invention is preferably so chosen that all particles pass through a screen with a mesh size of 0.1 mm.

In the case where the insulating layer is formed from an insulating composition in accordance with the present invention and comprises a polyurethane, asbestos fibres, lithopone and ammonium pentaborate, there remains, after the burning away of the solid propellant insulated therewith in the rocket combustion chamber, a shell having a hard and smooth internal surface without visible erosion caused by the combustion gases and an outer surface adjoining the wall of the combustion chamber which is still as elastic as before the burning operation. Because of its mechanical, thermal and dimensional stability, this shell is able effectively to protect the rocket combustion chamber from the action of temperature and, even during the burning of the solid propellant, does not give rise to any smoke.

Insulating layers for solid rocket propellant compositions in accordance with the present invention are preferably so produced that the separate components of the insulating composition are mixed in a conventional mixing apparatus, advantageously under vacuum, to form a bubble-free composition. Before this composition is applied to the solid propellant which is to be insulated, the surface of the propellant should first of all be free from any adhering dust, grease or solvent and possibly coated with an adhesion promoter. Thereafter, the solid propellant is centered and fixed as a mould core in a metal (preferably steel) pressure mould, advantageously coated on the inside with polytetrafluoroethylene such as that known as Teflon (Trade

Mark), in such a way that it is spaced from the surface of the mould by a distance equal to the desired thickness of the insulating layer. The insulating composition is then forced, for example, by means of a hydraulic pressure-applying arrangement, into the mould until it emerges at the discharge openings provided and it is then cured, e.g. by being heated to a temperature in the range of from 20° to 80°C., advantageously from 45° to 60°C. As adhesion promoter, there may be used for example 2,4- or 2,6-toluylene diisocyanate, or a mixture of these two substances.

It can be advantageous to produce foils, mats or sheet material from the insulating composition of the present invention by disposing the composition in a bubble-free state between for example polyethylene surface foils and then rolling out the composite structure to form a foil, mat or sheet of predetermined thickness. Thereafter the composition is cured or hardened between the polyethylene surface foils, possibly with use of heat if necessary. The resultant insulating foils, mats or sheets thus produced can subsequently be united, for example by adhesion, with the surface of the propellant to provide an insulating layer therefor. As adhesive, there is preferably used a material of the type used as binder for the insulating composition of the present invention. The propellant surface to be insulated can possibly be treated beforehand with an adhesion promoter of the type indicated above.

The following Examples illustrate the invention.

#### Example 1

25.24 parts of a viscous, pre-polymerised diisocyanate obtained from toluylene diisocyanate and butane-1,4-diol with a mean molecular weight of 2000 and an effective isocyanate content of 4% were mixed with a solution of 2.76 parts of methylene-bis-*o*-chloraniline in 7 parts of dimethylglycol phthalate and 10 parts of ammonium oxalate (grain size <100 $\mu$ ) and 55 parts of heat-treated asbestos fibres with an average fibre length of about 3 mm. were added thereto. After being well mixed under vacuum, a paste which could be brushed or sprayed was obtained, this paste having the following composition:

35% by weight of polyurethane prepolymer-based binder

10% by weight of ammonium oxalate

55% by weight of asbestos.

The paste had a processing time (pot life) of about 40 minutes. It hardened at 20°C. within 3 days and at 80°C. within 16 hours.

#### Example 2

25.24 parts of a viscous, pre-polymerised diisocyanate obtained from toluylene diisocyanate and butane-1,4-diol, with a mean

molecular weight of 2000 and an effective isocyanate content of 4%, were mixed with a solution of 2.76 parts of methylene-bis-*o*-chloraniline in 7 parts of dimethylglycol phthalate and 10 parts of oxamide (grain size <100 $\mu$ ) and 55 parts of heat-treated asbestos fibres with an average fibre length of about 3 mm. were added thereto. After being well mixed under vacuum, a paste which could be spread or sprayed was obtained, this paste having the following composition:

35% by weight of polyurethane prepolymer-based binder

10% by weight of oxamide

55% by weight of asbestos.

The paste had a processing time (pot life) of about 40 minutes. It hardened at 20°C. within 3 days and at 80°C. within 16 hours.

#### Example 3

50.54 parts of a viscous, pre-polymerised diisocyanate obtained from toluylene diisocyanate and butane-1,4-diol, with a mean molecular weight of 2000 and an effective isocyanate content of 4%, were mixed with a solution of 5.55 parts of methylene-bis-*o*-chloraniline in 14 parts of dimethylglycol phthalate and 25 parts of oxamide (grain size <100 $\mu$ ) and 5 parts of MgO fibres were added thereto. After being well mixed under vacuum, a paste which could be spread or sprayed was obtained, this paste having the following composition:

70% by weight of polyurethane prepolymer-based binder

25% by weight of oxamide

5% by weight of magnesium oxide fibres.

The paste had a processing time (pot life) of about 50 minutes. It hardened at 20°C. within 3 days and at 80°C. within 16 hours.

#### Example 4

32.40 parts of a viscous, pre-polymerised diisocyanate obtained from toluylene diisocyanate and butane-1,4-diol, with a mean molecular weight of 2000 and an effective isocyanate content of 4%, were mixed with a solution of 3.50 parts of methylene-bis-*o*-chloraniline in 9 parts of dimethylglycol phthalate. Added to this mixture were 3 parts of lithopone known under the designation "Silbersiegel" (grain size <50 $\mu$ ), 7 parts of ammonium pentaborate tetrahydrate (grain size 100 $\mu$ ) and 45.10 parts of heat-treated asbestos fibres with an average fibre length of about 3 mm. After being well mixed under vacuum, a paste which could be spread or sprayed was obtained, this paste having the following composition:

44.9% by weight of polyurethane prepolymer-based binder

45.1% by weight of asbestos

3.0% by weight of lithopone

7.0% by weight of  $(\text{NH}_4)_2\text{B}_4\text{O}_{10} \cdot 4\text{H}_2\text{O}$ .

The paste had a processing time (pot life)

of about 40 minutes. It hardened at 20°C. within 3 days and at 80°C. within 16 hours.

#### Example 5

A conventional double base POL solid rocket propellant of the end burner type with a diameter of 76 mm. and a length of 138 mm. was freed from any adhering dust, grease and solvents, and coated with a thin film of a liquid mixture of 2,4- and 2,6-toluylene diisocyanate to give a coating weight of about 30 mg/cm<sup>2</sup> of surface.

After this diisocyanate film had been completely dried in air, the propellant was fixed in a cylindrical steel mould having internal walls coated with Teflon and an internal diameter of 80 mm. so that there was a uniform gap of 2 mm. between the propellant and the internal surfaces of the mould. By means of a hydraulic pressing arrangement, an insulating composition of the type indicated in Examples 1 to 4 was now forced under a pressure of 100 kg/cm<sup>2</sup> into the cylindrical steel mould until the solid propellant was completely enclosed by a layer of the composition and excess composition issued from discharge openings in the mould. The mould was thereafter heated for 24 hours to a temperature of 60°C. to harden the layer coating the propellant and then the propellant composition was removed from the steel mould. One end face of the propellant was then exposed by turning on the lathe so that the subsequent ignition of the propellant in the rocket combustion chamber could take place at this face.

#### Example 6

A conventional double base POL solid rocket propellant of the end burner type and having a diameter of 100 mm. and a length of 150 mm. was freed from any adhering dust, grease and solvents, and coated with a thin film of a liquid mixture of 2,4- and 2,6-toluylene diisocyanate. After this diisocyanate film had been completely dried in air, the propellant was clamped on a lathe between two plano-parallel end discs of light metal bearing against the end faces of the cylindrical solid propellant composition, said discs having a diameter corresponding to the intended external diameter of the finally insulated propellant. The solid propellant composition is so centered between the discs that the thickness of the insulating layer is set by the end discs projecting uniformly beyond the propellant on all sides. Thereafter, the propellant was slowly rotated on the lathe and a layer of an insulating composition of the type indicated in Examples 1 to 4 was applied to the propellant by means of a straight spreading edge and then allowed to dry completely. The insulating layer was hardened within 24 hours at 60°C.

#### Example 7

A solid propellant was provided with a hardened insulating layer of thickness 2 mm using the insulating composition described in Example 4 and the procedure described in Example 5. The insulated propellant was test fired in a rocket combustion chamber. The propellant burnt for more than 16 seconds and the layer maintained complete insulation. After the firing, the layer had only a slightly carbonised, smooth and hard internal surface without visible erosion by the combustion gases. It could thus be seen that the insulating layer afforded reliable temperature protection for the rocket combustion chamber while having good mechanical and thermal stability.

#### WHAT WE CLAIM IS:—

1. An insulating composition suitable for the production of an insulating layer on a solid rocket propellant composition comprising a double base or polybase powder or in the form of a composite solid propellant, which insulating composition comprises:—
  - (a) from 30 to 90% by weight of a solvent-free hardenable binder comprising a prepolymer, a condensate, or a mixture thereof,
  - (b) from 5 to 65% by weight of an inorganic filler, and
  - (c) from 5 to 50% by weight of a substance which absorbs heat by undergoing an endothermic reaction as the insulating composition burns.
2. An insulating composition as claimed in Claim 1, wherein the binder hardens at ambient temperatures.
3. An insulating composition as claimed in Claim 1 or 2, wherein the filler has been subjected to a preheating treatment.
4. An insulating composition as claimed in Claim 1, 2 or 3, wherein the filler is in the form of fibres.
5. An insulating composition as claimed in Claim 4, wherein the fibres are asbestos fibres.
6. An insulating composition as claimed in Claim 5 when appendant to Claim 3, wherein the asbestos fibres have an average length of 3 mm and have been preheated at a temperature of up to 1000°C. for from 1 to 4 hours.
7. An insulating composition as claimed in Claim 4, wherein the fibres are fibres of glass, quartz or magnesium oxide.
8. An insulating composition as claimed in Claim 4, wherein the fibres are boron, silicon, carbon or titanium fibres.
9. An insulating composition as claimed in any one of Claims 1 to 3, wherein the filler is in the form of a powder.
10. An insulating composition as claimed in Claim 9, wherein the powder is titanium dioxide, silicon dioxide, lithopone or barium sulphate.
11. An insulating composition as claimed

- in any one of Claims 1 to 8, wherein the filler comprises fibres in admixture with a powder.
- 5 12. An insulating composition as claimed in Claim 11, wherein the filler comprises asbestos fibres in admixture with lithopone powder.
- 10 13. An insulating composition as claimed in any one of the preceding claims, wherein the binder comprises a polyurethane prepolymer.
- 15 14. An insulating composition as claimed in Claim 13, wherein the polyurethane prepolymer is derived from toluylene diisocyanate and butane-1,4-diol.
- 20 15. An insulating composition as claimed in Claim 14, wherein the polyurethane prepolymer has a mean molecular weight of 2000 and an effective isocyanate content of 4% by weight.
- 25 16. An insulating composition as claimed in any one of Claims 13 to 15, wherein the binder includes an amine as curing agent for the polyurethane prepolymer.
- 30 17. An insulating composition as claimed in Claim 13, wherein the binder comprises (a) from 63.1 to 81.1 parts by weight of a polyurethane prepolymer having a mean molecular weight of 2000 and an effective isocyanate content of 4% by weight and being derived from toluylene diisocyanate and butane-1,4-diol, (b) from 6.9 to 8.9 parts by weight of methylene-bis-*o*-chloraniline, and (c) from 30 to 10 parts by weight of dimethyl glycol phthalate.
- 35 18. An insulating composition as claimed in any one of Claims 1 to 12, wherein the binder comprises a poly-epoxide resin prepolymer.
- 40 19. An insulating composition as claimed in any one of Claims 1 to 12, wherein the binder comprises a polyester resin prepolymer.
- 45 20. An insulating composition as claimed in any one of Claims 1 to 12, wherein the binder comprises a diene prepolymer.
- 50 21. An insulating composition as claimed in any one of the preceding claims, wherein said substance sublimates when heated.
- 55 22. An insulating composition as claimed in any one of Claims 1 to 20, wherein said substance decomposes endothermally when heated and forms gaseous decomposition products and no residue.
23. An insulating composition as claimed in Claim 22, wherein said substance is an ammonium salt or an acid amide of an aliphatic dicarboxylic acid having from 2 to 8 carbon atoms.
24. An insulating composition as claimed in Claim 23, wherein said dicarboxylic acid is a straight chain acid.
25. An insulating composition as claimed in Claim 24, wherein said substance is ammonium oxalate or oxamide.
26. An insulating composition as claimed in Claim 22, wherein said substance is a synthetic plastics material.
27. An insulating composition as claimed in Claim 26, wherein said plastics material is an oxymethylene polymer.
28. An insulating composition as claimed in Claim 27, wherein said oxymethylene polymer is a polymer of formaldehyde.
29. An insulating composition as claimed in any one of Claims 1 to 20, wherein said substance decomposes endothermally when heated to form, either alone or together with another component of the composition, a refractory oxide residue.
30. An insulating composition as claimed in Claim 29, wherein said substance comprises an ammonium salt of an isopoly acid of boron, silicon, phosphorus or titanium and/or an ammonium salt of a heteropolyacid of boron, silicon, phosphorus or titanium.
31. An insulating composition as claimed in Claim 30, wherein said substance is ammonium pentaborate.
32. An insulating composition as claimed in any one of the preceding claims, wherein said substance has a grain size such that all particles of the substance pass through a screen of mesh size 0.1 mm.
33. An insulating composition as claimed in Claim 1, substantially as hereinbefore described in any one of Examples 1 to 4.
34. A method of providing an insulating layer on a solid rocket propellant composition comprising a double base or polybase powder or in the form of a composite solid propellant, which method comprises applying to the solid rocket propellant composition a layer of an insulating composition as claimed in any one of the preceding claims and allowing or causing the insulating composition to harden.
35. A method according to Claim 34, which comprises pretreating the solid rocket propellant composition with 2,4-toluylene diisocyanate and/or 2,6-toluylene diisocyanate before applying the insulating composition.
36. A method according to Claim 34 or 35, which comprises locating the solid rocket propellant composition in a mould so that it is spaced from the internal surfaces of the mould, and introducing the insulating composition into the space between the solid rocket propellant composition and said surfaces.

37. A method according to Claim 34, substantially as hereinbefore described in Example 5 or 6.

- 5 38. A solid rocket propellant composition whenever provided with an insulating layer by the method claimed in any one of Claims 34 to 37.

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TITLE: Insulating compsn for solid - rocket  
fuel-comprises polymer binder filler and endothermic  
reacting substance

----- KWIC -----

Basic Abstract Text - ABTX (1):

An insulating compsn. suitable for forming an insulating layer on solid rocket propellant comprises (a) 30-90 wt.% of solvent-free binder which is a polymer, condensate or mixt. of the two, (b) 5-65 wt. % of an inorganic filler (pref. asbestos fibres), (c) 5-50 wt. % of a substance which absorbs heat by undergoing an endothermic reaction when the insulating compsn. burns. The insulating layer provides temp. protection for the rocket combustion chamber. The binder (a) is pref. a prepolymer of polyepoxide, polyester, diene homo- or copolymer, or polyurethane type which can be cured at room temp. or elevated temp. after the insulating layer has been applied to the surface of the propellant compsn. The substance (c) includes ammonium salts and acid amides of C2-8 aliphatic dicarboxylic acids, e.g. ammonium oxalate or oxamide, oxamethylene polymers or formaldehyde polymers or ammonium salts of isopoly and/or heteropoly acids e.g.  $(\text{NH}_4)\text{B}_5\text{O}_8 \cdot 4\text{H}_2\text{O}$ .